



ACCIDENT RECONSTRUCTION ANALYSIS

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Padmaraju v. Singh
Date of incident: October 5, 2001

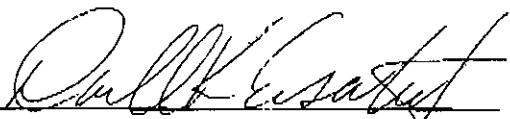
ARCCA File No. 2107-018

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Prepared for:

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July 22, 2005

Prepared by: 
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**Synopsis:**

On October 4, 2001, in Millcreek Township, Erie County, Pennsylvania, a 1996 Eclipse, owned by Rajesh Padmaraju, was illegally parked in the right westbound lane of I-90. At the time, 11:34 p.m., the road was dark with periodic rain present. A 1997 Subaru Legacy was traveling westbound in the right lane of I-90 approaching the parked Eclipse. Mr. Padmaraju, a pedestrian, was outside of his vehicle in the roadway next to the open door of his Eclipse. The Subaru stopped or slowed behind the Eclipse, awaiting an opportunity to move into the left lane to go around the Eclipse. A 2000 Peterbilt tractor/trailer driven by Mandeep Singh was westbound in the right lane of I-90 behind an unidentified tractor/trailer which was also westbound in the right lane. The Singh tractor/trailer followed the front tractor/trailer into the left lane where the lead vehicle braked. The Singh Peterbilt moved back to the right lane where it struck the Nolan Subaru with the cab and struck the pedestrian and the Eclipse with the trailer and drove to a stop on the berm on north side of I-90 westbound. Upon being struck by the tractor/trailer, the Subaru struck the Eclipse and came to rest in north lane of I-90 westbound. Upon being struck by the tractor/trailer, the pedestrian was thrown approximately 85 feet to the north berm.

ARCCA, Inc. was retained to investigate this accident and evaluate vehicle speeds and crash dynamics. This analysis is based on information currently available to ARCCA. ARCCA reserves the right to revise or supplement this report should additional information become available.

My findings to date include:

- The Padmaraju Eclipse was stopped with the vehicle predominantly within the right traffic lane of westbound I-90, consistent with the police report statement that the Eclipse was "illegally parked."
- Mr. Padmaraju was outside the Eclipse, standing in the traffic lane of westbound I-90 at the time of the crash.
- The Nolan Subaru was stopped or slowing behind the Eclipse in the right lane of I-90 at the time of the crash.
- The Singh tractor/trailer moved from the right lane of westbound I-90 to the left lane when the tractor/trailer that it was following had done the same prior and began heavily braking. The Singh tractor/trailer moved back toward the right lane after Mr. Singh became aware of tractor/trailers approaching from the rear while he was heavily braking. The right front of the tractor struck the left rear of the Subaru.
- The Nolan Subaru sustained heavy sideswipe damage across the left side of the vehicle with limited intrusion into the left side of the vehicle including the driver's compartment. The Subaru was pushed forward into contact with the rear of the Padmaraju Eclipse.
- The right rear of the trailer, and likely the right side of the tractor, contacted the Eclipse within the right traffic lane of westbound I-90.



- Mr. Padmaraju, as a pedestrian in the traffic lane of westbound I-90, was struck by the tractor/trailer as it passed alongside and damaged the Eclipse on its left side. His body was involved with the right rear tandem wheels of the trailer, and he was found 85 feet from the point of impact.
- In the area of the crash, there was sufficient hard shoulder for Mr. Padmaraju to have parked the Eclipse on the paved shoulder, completely out of the lane of travel on I-90 westbound. Beyond the paved shoulder, there was an additional unpaved, grassy shoulder.
- The sole cause of this crash was Mr. Padmaraju's parking of the Eclipse within the traffic lane of westbound I-90. There are no indications of improper speed or speeds too fast for the conditions by the Singh tractor/trailer.

Purpose:

The purpose of this report is to provide a scientific evaluation of the vehicle dynamics in this crash. This report provides a scientific analysis of the impact of the vehicles and the crash environment to which the occupants of these vehicles are exposed.

The following engineering analysis has been undertaken utilizing the Scientific Method in evaluating the aforementioned issues of this crash. The methodologies, formulas, and computer programs applied are commonly used and accepted in the accident reconstruction field.

Qualifications:

I am presently employed as a Senior Engineer for ARCCA, Inc., working as a consultant in the fields of occupant crash protection, crash safety, crashworthy seating and seat belt restraint engineering, and accident analysis and reconstruction. I have a Bachelor of Science degree in Mechanical Engineering, and I am a licensed Professional Engineer (PE) and a member of the Society of Automotive Engineers. I have authored numerous publications on the topic of occupant seating and restraint systems and vehicle occupant crash protection. I am an accredited accident reconstructionist by the Accreditation Commission for Traffic Accident Reconstructionists.

I have worked in the research, development, and simulation of occupant restraints, seats, and crash protection devices for more than 22 years. During this time, I have designed, developed, and extensively tested occupant seating, restraint systems, and energy absorption systems. My testing and research has been performed with both anthropomorphic test devices and live human subjects. As such, I am intimately familiar with the theory and operation of occupant seating and restraint systems and their components, the requirements and criteria for their design and implementation, as well as the techniques and processes for evaluating their performance and injury potential.



Corollary to the occupant crash protection experience, I have worked in the development and analysis of vehicle crashworthiness and vehicle dynamics resulting from a crash. In developing occupant protection systems, an understanding of the crash forces inflicted on and by the vehicle is vital. I have analyzed the response of vehicles to crash forces throughout my 22 years in the vehicle crashworthiness field. I have formulated and conducted crash tests of automobiles and sled tests of automobile and helicopter structures.

Materials Reviewed:

In the course of my investigation, I reviewed the following materials specific to this matter. I reserve the right to supplement this report upon the review of additional information.

- Commonwealth of Pennsylvania Police Crash Reporting Form, Incident number E1-975963, October 5, 2001
- Color photographs of accident scene
- Color photographs of the autopsy
- Statement transcript of Susan Nolan, dated December 13, 2001, and March 13, 2002
- Deposition transcripts of Kevin Dunbar, Amanda DiBacco, and Lisa K. Smith, dated October 27, 2004
- Deposition transcript of Trooper Ronald Morgan, dated October 27, 2004
- Deposition transcript of Trooper Richard Pottorf, dated October 27, 2004
- Deposition transcript of Sergeant Dennis Kay, dated September 13, 2004
- Deposition transcript of Trooper Joseph Cannon, dated October 27, 2004
- Deposition transcript of Trooper David Peck, dated September 13, 2004
- Deposition transcript of Susan Nolan, dated January 11, 2005
- Deposition transcript of Mandeep Singh, dated April 15, 2005
- Repair estimate for ISD Feterbilt
- State Farm Vehicle damage report for Nolan Subaru
- Liberty Mutual auto appraisal report for Padmaraju Mitsubishi
- USDOT Federal Motor Carrier Safety Administration records for ISD Transportation
- Inspection of the accident site

References:

In the course of my investigation, I referred to the following materials in support of my opinions and methodology in this matter. However, this does not include all general data used in the normal course of accident investigation.



- Pennsylvania Consolidated Statutes, Vehicle Code (Title 75), Part III, Chapter 33. Rules of the Road in General, Subchapter E §3354. Additional Parking Regulations.
- Fricke, L.B., "Traffic Accident Reconstruction", Northwestern University Traffic Institute, Evanston, IL, 1990
- Campbell, K.L., *Energy Basis for Collision Severity*, Society of Automotive Engineers, Warrendale, PA, Publication 740565, 1974
- 4N6 Expert Autostats computerized database
- Expert VIN DeCoder
- CRASH Technical Manual, National Highway Traffic Safety Administration

Police Crash Report

According to the Police Crash Report, the Padmaraju Eclipse was illegally parked in the northwest bound lane of SR90. The Nolan Subaru was traveling westbound in the north lane of I-90 approaching the parked Eclipse. Mr. Padmaraju, a pedestrian, was outside of his vehicle in the roadway next to the open door of his Eclipse. The IDS tractor/trailer was westbound in the north lane of I-90 behind an unidentified tractor/trailer which was also westbound in the north lane. The IDS tractor/trailer struck the Nolan Subaru with the cab and struck the pedestrian and the Eclipse with the trailer and drove to a stop on the berm on north side of I-90 westbound. Upon being struck by the tractor/trailer, the Subaru struck the Eclipse and came to rest in north lane of I-90 westbound. Upon being struck by the tractor/trailer, the pedestrian was thrown approximately 85 feet to the north berm. The Eclipse remained in place, open driver's side door being torn from car.

Vehicle Information—1996 Mitsubishi Eclipse, VIN 4A3 AK34Y1 TE340603:

The vehicle was not available for inspection at the time of my investigation. This vehicle is identified as a 1996 Mitsubishi Eclipse 2-door coupe. Photographs of the vehicle demonstrated that it had contact damage to the left side, including the separation of the driver's door from the vehicle, and lighter damage to the rear. The damage to the left side included lateral displacement of the rear fender from the taillight to the B-pillar. The driver's door was separated from the car at the hinges, which were forced forward at the A-pillar and tore loose. The left rear wheel had been displaced forward and was damaged in the collision.

The rear of the Eclipse exhibited contact damage across the rear bumper. The flexible bumper cover was distorted across its width.

The driver's door came to rest forward of the vehicle. The inner door panel had separated from the door, and the door's structure exhibited contact damage to its inboard surface.



1996 Mitsubishi Eclipse

**Vehicle Information—1997 Subaru Legacy L 4-door wagon,
VIN 4S3 BK4353 V6306583:**

The vehicle was unavailable for inspection at the time of my investigation. This vehicle is identified as a 1997 Subaru Legacy L 4-door wagon. The photographs of the vehicle demonstrated that it had contact damage to the left rear and side, with lighter damage to the left front. The damaged area along the left side showed collision forces from the rear, pushing the damaged material forward. The collision contact to the rear of the Subaru initiated inboard of the left taillight and progressed forward into the rear seat area. The driver's door was not substantially shortened, but was jammed in place and may have had the outer skin removed in this impact. The driver's door was further damaged in extrication efforts when the hinges were detached. Extrication damage also included the removal of the roof from the vehicle.

Additional collision contact damage was evident along the left front fender which was distorted laterally inboard at the front. The outer left side of the front bumper was torn forward. The remainder of the front bumper, hood and grill area had sustained light frontal impact damage.



1997 Subaru Legacy L wagon

Vehicle Information—2000
VIN 1XP 5DB9X9 4D469113:

The vehicle was not available for inspection at the time of my investigation. This vehicle is identified as a 2000 Peterbilt tractor with an attached trailer. Photographs of the vehicle demonstrated that it had contact damage to the right front of the tractor and the right rear wheels of the trailer. The right front outboard bumper and the left front fender were damaged from contact, and the step/battery box below the right cab door were displaced rearward.

The only other noted damage on the vehicle were paint scrapings on the right outboard wheels of the trailer. Both blue and red paint are visible on the wheels. The forward hub cover appears to be damaged and fluid had leaked onto the rim. The shoe of the pedestrian was found between the rearmost tires.



2000 Peterbilt Model 379

Site Information:

The accident site was located on Interstate 90 in Millcreek Township, Erie County, Pennsylvania. The roadway in this area is straight and level, at the end of an incline from an underpass at the bottom of a hill. The roadway is an asphalt-paved two-lane cartway with a 10-foot paved shoulder on the right. A grassy shoulder extends another 11 feet to a shallow ditch to the north and another 4 feet to the end of the trimmed area. Speed limit for the roadway was 55 mph. There are no street lights or other illumination in the immediate area.



Accident site on I-90 westbound

Accident Reconstruction:

This incident involved three vehicles and a pedestrian in a sequence of collisions on a relatively straight, level roadway in rainy weather. The initial impact occurred in the right westbound lane of I-90 with the two automobiles being moved westward to final rest positions at the outside of the right lane and partially on the right shoulder. The tractor/trailer continued westbound to a controlled stop at the side of the roadway. Mr. Padmaraju, outside of his vehicle on the driver's side in the right traffic lane, was struck by the trailer as it passed.

The relative positions of the vehicles at rest, the damage patterns to each vehicle, and the observation of the basic laws of physics allow some aspects of the crash to be accurately analyzed. However, this crash sequence does not lend itself to the standard methods of *quantitative* accident reconstruction analysis, i.e., crush energy analysis for speed changes at impact, and conservation of momentum using uncontrolled vehicle movements to final rest.

From a basic accident reconstruction analysis, the vehicle interactions can be evaluated. The front right bumper and fender area of the tractor/trailer initially struck the left rear of the stopped or slowing Subaru. The collision resulted in extensive damage to the left rear of the Subaru and observable damage to the tractor bumper and fender, and subsequently the air intake and step/battery box on the right side of the tractor cab.



The Subaru was subsequently damaged on nearly the full width of its front end by striking the rear of the Eclipse. As these vehicles progressed forward, the rear tandem wheels of the trailer struck the front left of the Subaru, continuing on to contact the left rear of the Eclipse, its open driver's door, and Mr. Padmaraju who was located on the driver's side of the Eclipse in the traffic lane. It should be noted that all crash forces exerted onto the automobiles from the vehicle(s) behind are directed, in order, from the rear and left. As a result of these principal directions of forces, movements of the vehicles can be determined.

Thus, the Subaru was initially behind the Eclipse at a slight angle west-southwesterly in the right lane of the roadway. The Eclipse was ahead of the Subaru, parked at a slight angle northerly, mostly within the right traffic lane. The collision of the tractor and the Subaru moved the Subaru forward, into contact with the rear of the Eclipse. After the tractor and the Subaru separated, the rear tandem wheel sets of the trailer then made contact with the Subaru and the right rear fender of the Eclipse. During this sequence, the driver's door of the Eclipse was contacted by the front of the tractor and/or the right wheels of the trailer, separating the door from the Eclipse. For Mr. Padmaraju to have become involved with the rear wheels of the trailer, he must have been positioned on the driver's side of the Eclipse.

The movements of the articulated tractor/trailer show that the rig was moving from left to right at the time of the impact. The tractor struck the Subaru, but did not have any substantial interaction with the Eclipse, aside from a possible, relatively minor, collision with the open door. As the tractor moved leftward as it separated from the collision with the Subaru, the trailer did not make contact with the side of the Subaru.

Consistent with the physical evidence and the testimonies of the involved parties, some conclusions in this investigation are as follows: (Pages cited are from deposition testimonies.)

The Padmaraju Eclipse was stopped with the vehicle predominantly within the right traffic lane of westbound I-90, consistent with the police report statement that the Eclipse was "illegally parked".

- **Trooper David Peck**
 - o Indicated the prime factor in this crash was the Eclipse illegally stopped on the road. (p 48)
- **Trooper Ronald Morgan**
 - o Believes plaintiff's vehicle was in the right-hand lane of the roadway, stopped (p 36)
- **Susan Nolan**
 - o The back end of the red vehicle was blocking the right lane. (p 35)
 - o The driver side door was open partly into the driving lane. (p 36)
- **Mandeep Singh**
 - o When I came in the right lane, I saw there were two cars stopped there. (p 81)
 - o The red car may have been partly on the shoulder, but it was facing straight ahead. (p 90)



Mr. Padmaraju was outside the Eclipse, standing in the traffic lane of westbound I-90 at the time of the crash.

- **Trooper David Peck**
 - o Unit number three [on the police report] was actually the person. His vehicle was actually unit one. (p 49)
- **Trooper Ronald Morgan**
 - o Believes the plaintiff was standing within the doorway of the vehicle at impact (p 35)
- **Susan Nolan**
 - o I saw him out of his vehicle, and about 10 seconds later I was rear-ended. (p 28)
 - o He walked behind his car, to the center of the back of his car. (p 37)
 - o Since the back end of his car was in the driving lane, he was probably standing the driving lane, also. (p 38)
 - o I was still trying to get out, and saw the man at the right-hand corner rear of his car, and that's the last time I saw him. (p 40)
- **Mandeep Singh**
 - o The red car's door was open, and the driver of the red car was standing in front of the door. (p 86)

The Nolan Subaru was stopped or slowing behind the Eclipse in the right lane of I-90 at the time of the crash.

- **Susan Nolan**
 - o I was still moving until I got within 20 ft of him, then I had to stop, because I couldn't get out. (p 27)
- **Mandeep Singh**
 - o When I came in the right lane, I saw there were two cars stopped there. (p 81)
 - o The black car was right behind the red car, there was not that much distance between them. (p 86)

The Singh tractor/trailer moved from the right lane of westbound I-90 to the left lane when the tractor/trailer that it was following had done the same prior and began heavily braking. The Singh tractor/trailer moved back toward the right lane after Mr. Singh became aware of tractor/trailers approaching from the rear while he was heavily braking.

- **Mandeep Singh**
 - o The other truck did not use signals, he immediately braked and came in the left lane. (p 61)
 - o I also went into the left lane. (p 63)
 - o He really put the brakes on fast. I also put on the brakes. (p 68)
 - o For safety, I went into the right lane. If I did not go to the right lane, there were trucks behind me that would have hit me. (p 70)

The right front of the tractor struck the left rear of the Subaru.

- **Mandeep Singh**
 - o The part that impacted the black car was the right front fender of the truck.



The Nolan Subaru sustained heavy sideswipe damage across the left side of the vehicle with limited intrusion into the left side of the vehicle including the driver's compartment.

- **Susan Nolan**

- o I couldn't get out of my car, the left side was smashed in and they had to cut the roof off and smash the windshield to get me out. I had my seatbelt on. (p 48)

Mr. Padmaraju, as a pedestrian in the traffic lane of westbound I-90, was struck by the tractor/trailer as it passed alongside and damaged the Eclipse on its left side. His body was involved with the right rear tandem wheels of the trailer, and he was found 85 feet from the point of impact.

- **Amanda DiBacco**

- o Patient was found about 100 feet west of where his car was located

- **Trooper David Peck**

- o In police report he cited that the body was found about 85 feet further west

The sole cause of this crash was Mr. Padmaraju's parking of the Eclipse within the traffic lane of westbound I-90. There are no indications of improper speed or speeds too fast for the conditions by the Singh tractor/trailer.

- **Trooper Richard Pottorf**

- o No accident reconstruction performed because party at fault was determined to be the deceased.

- **Trooper David Peck**

- o No violations by the truck in this incident
- o The truck was traveling at 55 mph, the posted limit
- o No hazard flashers were activated on the Eclipse

- **Susan Nolan**

- o The semi was going no more than 35 or 40 mph. (p 40)
- o The vehicles that were passing on the left were not excessively speeding. (p 67)

In the area of the crash, there was sufficient hard shoulder for Mr. Padmaraju to have parked the Eclipse on the paved shoulder, completely out of the lane of travel on I-90 westbound. The 10-foot-wide paved shoulder would have been more than sufficient to safely park a less than 6-foot wide Eclipse. Beyond the paved shoulder, there was an additional unpaved, grassy shoulder.

A following distance of 150 feet by Mr. Singh prior to the incident allowed more than 2 seconds of perception/reaction time to the actions of the vehicle ahead on the open, limited-access highway. As Mr. Singh closed on the hard-braking vehicle ahead after the lane change, he made the decision to move back to the apparently clear right lane for the safety of his rig and those following. This would have been a safe, reasonable action but for the illegal action of Mr. Padmaraju, who had parked his vehicle within the lane of travel of an interstate highway in an unlit, rainy section of the highway.



Conclusions:

Based on my experience in the fields of accident reconstruction and vehicle occupant crash protection, I can conclude with a reasonable degree of scientific certainty, the following:

1. The Padmaraju Eclipse was stopped with the vehicle predominantly within the right traffic lane of westbound I-90, consistent with the police report statement that the Eclipse was "illegally parked."
2. Mr. Padmaraju was outside the Eclipse, standing in the traffic lane of westbound I-90 at the time of the crash.
3. The Nolan Subaru was stopped or slowing behind the Eclipse in the right lane of I-90 at the time of the crash.
4. The Singh tractor/trailer moved from the right lane of westbound I-90 to the left lane when the tractor/trailer that it was following had done the same prior and began heavily braking. The Singh tractor/trailer moved back toward the right lane after Mr. Singh became aware of tractor/trailers approaching from the rear while he was heavily braking. The right front of the tractor struck the left rear of the Subaru.
5. The Nolan Subaru sustained heavy sideswipe damage across the left side of the vehicle with limited intrusion into the left side of the vehicle including the driver's compartment. The Subaru was pushed forward into contact with the rear of the Padmaraju Eclipse.
6. The right rear of the trailer, and likely the right side of the tractor, contacted the Eclipse within the right traffic lane of westbound I-90.
7. Mr. Padmaraju, as a pedestrian in the traffic lane of westbound I-90, was struck by the tractor/trailer as it passed alongside and damaged the Eclipse on its left side. His body was involved with the right rear tandem wheels of the trailer, and he was found 85 feet from the point of impact.
8. In the area of the crash, there was sufficient hard shoulder for Mr. Padmaraju to have parked the Eclipse on the paved shoulder, completely out of the lane of travel on I-90 westbound. Beyond the paved shoulder, there was an additional unpaved, grassy shoulder.
9. The sole cause of this crash was Mr. Padmaraju's parking of the Eclipse within the traffic lane of westbound I-90. There are no indications of improper speed or speeds too fast for the conditions by the Singh tractor/trailer.